a female in general appearance as its brood sisters. Several skilled poultrymen, when shown the bird, have unhesitatingly pronounced it a pullet.

Aside from a perfectly clear record, the marks of the operation, which are still visible, show that the bird when operated on must have been a male.

While possible that this particular individual may owe its feminized character to a constitutional condition, such as hen feathering, such an assumption is extremely improbable. Rather, it seems more probable that the bird has actually been feminized by the implanted ovaries in similar fashion to the rats and guinea-pigs of Steinach.

A full account of the bird will be published after it has been under observation for several months.

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### A THIRD ORDER RAINBOW

TO THE EDITOR OF SCIENCE: On September 11, as I stood near the lake in Beardsley Park, Bridgeport, Conn., I observed a rainbow in such an unusual position that it seems to be worthy of some short description. The rainbow was first noticed about a quarter of five in the afternoon, with the sun perhaps 60° from the zenith. The sky in general was clear, though there were heavy clouds above the eastern horizon and very light cloud streaks between the observer and the sun, with a few fleecy clouds near the zenith. No rain was falling, and probably none had fallen in the region for some time, nor was there indication that any would fall for hours; yet, between the observer and the sun, some 10° from the zenith, there appeared between two of the clouds a distinct rainbow, clearly observed by others whose attention was called to the phenomenon.

The bow was rather short, not over an eighth of a circumference, convex toward the sun, and showed plainly the usual rainbow colors. Not until the bow had faded to such an extent that the colors were no longer marked was it recalled that no accurate statement of the order of colors could be given. It is my impression now that the red was on the convex side.

Wood's "Physical Optics," second edition, p. 343, gives for the deviation produced by $K$ internal reflections in a sphere

$$D = 2(i - r) + k(\pi - 2r)$$

and for minimum deviation,

$$\cos i = \sqrt{\frac{\mu^2 - 1}{K^2 + 2K}}.$$

For $K = 3$, this gives

$$i = 76° 50,$$
$$r = 46° 55',$$
$$D = 318° 20',$$

whence the angle between the emergent and incident light would be about 42°. This would agree fairly well with the rough estimate of 50°. Hence the conclusion that the rainbow observed was the result of three internal reflections within suspended drops of such small size and number as to give no appearance of a cloud.

Various authorities, however, state with more or less emphasis that the bows corresponding to three reflections are never seen on account of the much more intense direct light from the sun. In the case cited above it would seem that the light clouds directly between the observer and the sun served to diminish the intensity of the direct light to such an extent that the bow was plainly seen.

This seems to be the only explanation for the bow, but considering the very light clouds noted above, the observation is all the more remarkable.

H. W. FARWELL

### A SOLAR HALO IN VIRGINIA

THE solar halo, a sketch of which is appended, was visible over a considerable portion of east Virginia for several hours on Sunday, November 2, 1913. It was observed by the writer at Fredericksburg, Virginia, at one P.M. on that day. The phenomenon was of the greatest brilliancy, the acessory "suns" being at times almost as brilliant as the sun itself. The great circles around the horizon were dis-

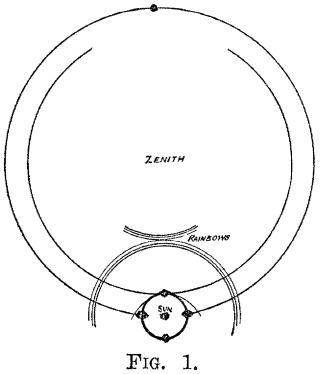


FIG. 1.

tinctly marked, and persisted for hours. The bright spot at the opposite pole from the sun was only occasionally visible. The rainbows were brilliantly colored and could be seen until the sun was almost down.

The sky at the time was almost clear, except for a few wisps of cloud and a thin haze which was densest directly over the face of the sun.

A. W. FREEMAN

## SCIENTIFIC BOOKS

*Photo-electricity.* By H. STANLEY ALLEN. London, Longmans, Green and Co., 1913. 8vo. Pp. ix + 221. Price $2.10 net.

*Photo-electricity.* By ARTHUR LLEWELYN HUGHES. Cambridge, The University Press, 1914. 8vo. Pp. viii + 144.

The present generation of physicists has seen the rapid and almost spectacular development of several important fields of activity in physics: such, for example, as the subject of electric waves, of kathode rays and electrons, of X-rays, and of radioactivity. While the subject of photo-electricity has not aroused the same widespread and popular interest as the subjects just mentioned, there are at present many reasons for believing that the study of photo-electric phenomena may prove to be of almost equal importance in its bearing upon theories of atomic structure and of radiation.

I imagine that most physicists have read the paper in which Hertz described his discovery of the photo-electric effect. The paper is reprinted in Hertz's "Ausbreitung der elektrischen Kraft" and in the English translation "Electric Waves." I can think of no scientific article which illustrates so well not only what research in experimental physics ought to be, but also how the results should be presented. It is a good illustration also of the importance of the unexpected things that so frequently turn up in experimental work. It will be remembered that the discovery of the photo-electric effect came as an incident in Hertz's work on electric waves. As difficulty was experienced in seeing the minute sparks that indicated the response of the resonator, he tried to improve matters by placing a box around the gap so as to screen the eyes. But instead of making it easier to see the sparks the box apparently made the resonator less sensitive. I imagine that most of us would have been content to call the attempted improvement a failure, and would have dismissed the matter with mingled feelings of mild wonder that the scheme didn't work, and regret that we had wasted so much time in making the box. But Hertz was not content to simply wonder. He set out to discover why the box had such an unexpected effect, and by a beautifully logical series of experiments and deductions he found the answer to his question. Since it appeared that the new phenomenon had no bearing upon what he regarded as his more important problem, he left its further study to others and returned to the subject of electric waves.

Hertz's paper aroused wide-spread interest and the work was quickly taken up by others. During the first nine years after Hertz's discovery more than one hundred articles dealing with the photo-electric effect were published, and interest in the subject has continued undiminished since. As no résumé of the subject has been published which is at all complete, it is clear that the physicist who wishes to make himself familiar with what has been done in this important field has no small task before him.[1] The almost simultaneous

[1] A résumé of work on the photo-electric effect was published in SCIENCE, Vol. IV., p. 853 and p. 890, 1896, which was, I believe, complete to the time of publication. The subject has developed so greatly since that time, however, that this summary has little more than historical interest.